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BY

GEORGE A. SOPER, PH.D.,

OF NEW YORK.

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MOSQUITO EXTERMINATION IN NEW YORK CITY.

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Before deciding on the means to be followed to get rid of mosquitoes in any locality, I believe it is a wise plan to give a good deal of attention to the particular kinds of mosquitoes to be dealt with and the circumstances under which they occur. In some places where this precaution has not been taken, extensive work has been done against mosquitoes which later investigation showed gave little trouble, while the insects which were the true offenders were overlooked.

To avoid the possibility of mistake, I advocate a careful observation of the times and places where the mosquitoes occur and the collection and identification of many specimens. From these facts a correct knowledge can be had of the location and kinds of breeding places which need to be destroyed.

In New York City there are several types of mosquitoes which, in my view, it is desirable to consider separately. One of these is the sordid mosquito, *Culex pungens*, the mosquito which is most apt to give trouble indoors at night. Another is the *Anopheles maculipennis* which has been found to be an agent by which malaria is carried from person to person. A third is the *Culex sollicitans*, more commonly known as the salt marsh mosquito. This insect bites by day and night, but is most commonly troublesome in the open air on calm days near the tide meadows.

It is a common belief among New Yorkers that

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such mosquitoes as occur on Manhattan Island come from New Jersey, the extensive breeding grounds on the Hackensack meadows, and the nearness of that celebrated region making this supposition seem probable.

To test the matter, several hundred mosquitoes were caught last summer along the western water front, and elsewhere in Manhattan, and their species determined. It was known that the characteristic Jersey mosquito was the *Culex sol-*

Stagnant Water and Sunken Lots in Upper Manhattan. The company advertising is said to own one thousand lots of this type.

licitans, and as the conditions on Manhattan Island for the breeding of these mosquitoes were not favorable, it was thought that if the *sollicitans* were present in large proportion, some color would be given to the theory that they came from across the river. When the examinations were finished, it was found that the mosquitoes caught were almost exclusively of the species *Culex pungens.*

It is well known that *Culex pungens* is not a salt marsh mosquito, but one whose larvæ often develop in stagnant water near habitations. A consideration of this fact led to a search for breeding places in Manhattan. The result was that the larvæ of *Culex pungens* were found in nearly all parts of the island. Wherever a trench or the foundations for a building were being made, or, in fact, pools of stagnant water from any cause existed, the eggs, larvæ and pupæ of the sordid mosquito were pretty certain to be discovered. In some cases other larvæ, notably those of the malaria mosquito, were found in the same water with *pungens.*

As might be expected, the excavations for the underground rapid transit railway afford ideal conditions for the propagation of *Culex pungens.* For many miles through the heart of the city, at the bottom of this trench, there are pools that are sheltered from wind and light. The number of mosquitoes which breed in these pools is incalculable. Probably hundreds of thousands are hatched out every warm day.

It would be profitable to know what becomes of the great number of mosquitoes hatched in New York in the summer time. In view of the extent and rapidity with which they multiply, it may seem curious that a plague of the insects has not visited the city. A partial explanation perhaps is, that most of the mosquitoes which come from the stagnant water in the built-up portions of the city do not find the conditions in the neighborhood favorable to their continued existence, and so perish at an early stage of their career. It is also probable that a large part of the larvæ fail to become strong-winged insects. Of those able-bodied mosquitoes which do emerge from the water, a considerable proportion are males, and as these do not bite human beings, they are not

noticed. Those which remain are comparatively few.

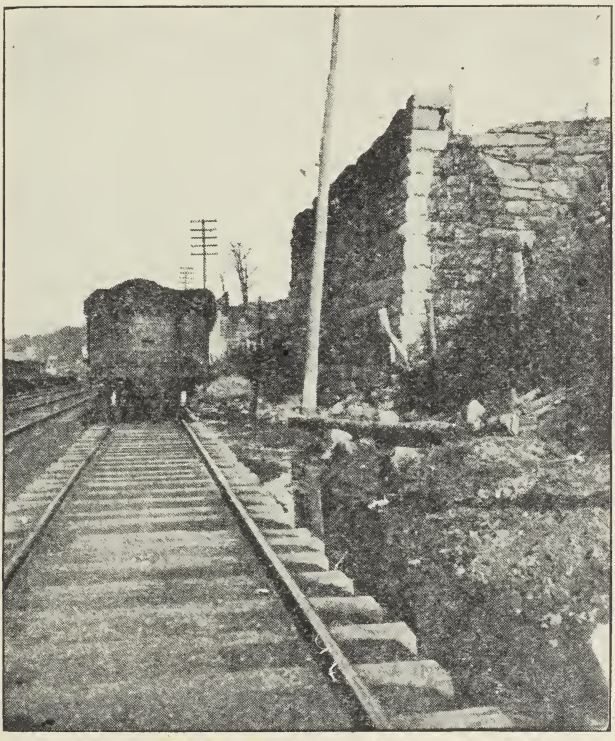
The sordid mosquito is seldom observed in New York in the daytime, but at twilight it emerges from its hiding place. If an entrance to a dwelling cannot immediately be effected it flies upward, searching diligently along the sides of the houses for an opening. I have observed *Culex pungens* in considerable numbers night after night, beating upon the screens of windows at a

Stagnant Water in Jerome Park Reservoir. Borough of Bronx.

height of over a hundred feet from the ground. Failing to get in they would disappear over the top of the house. Their fate beyond this point is beyond conjecture. I have never seen them fly downward.

The breeding places of the sordid mosquito in New York are by no means confined to the built-up portions of Manhattan, but occur with equal frequency in the rural districts of the city. Few

people have any idea how extensive these rural districts are. New York, as a whole, is not a crowded city; only 1,000 acres have a population of 250 persons or more to the acre. The average population per acre in Manhattan, as shown by the last U. S. Census, is 147.1 and the aver-

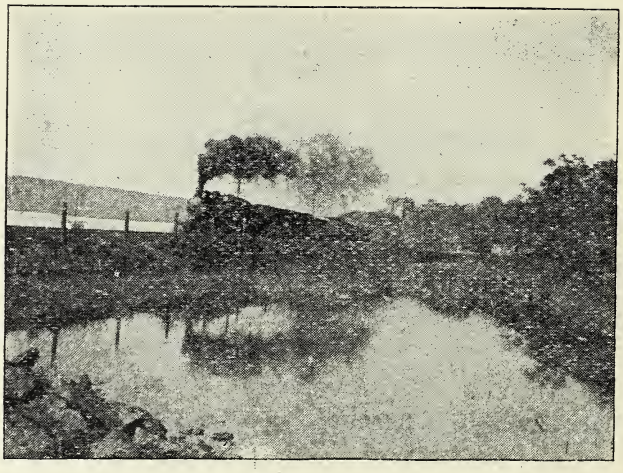


Imperfect Drainage on a Railway. Malaria Mosquitoes found here. New York Central Railroad, near 148th Street and Hudson River.

age for the whole city is less than 17. There are large stretches of country which have none of the attributes of city or even village life. Adding up some of these tracts, and comparing them with the total area of the city, we find that about 80 per cent. of the territory of New York

has a population of less than 20 people to the acre and that there are 93,000 acres which have a smaller average population per acre than 1.6. New York is, in fact, a collection of communities. The group includes two great cities, several small cities, a large number of towns and villages and an extensive area of strictly rural country. Throughout this large territory mosquitoes are more or less of a nuisance.

Excluding water due to engineering works and



On the Hudson. Pool produced in constructing the railroad.

natural pools and swamps, most of the breeding places of *Culex pungens* are due to a want of proper order and neatness about dwellings. As its name implies the sordid mosquito is not fastidious about its breeding places. Rain water in discarded buckets, butter tubs, cement or flour barrels, paint pots, broken dishes or boxes serve the insects well. The water in which the larvæ occur is often as foul as can be imagined. The presence of garbage, manure and human feces actually seems to favor their growth.

The larvæ of the sordid mosquito have been met with in New York as early as May and as late as the middle of November. The winged insects evidently live all winter in some houses. On Jan. 15 last, I caught two adult females on the wing in the corridor of a large hotel near Central Park.

From the standpoint of health, the most objectionable breeding places are neither those found in the densely populated nor wholly urban localities, but in the vicinity of thinly settled districts which are passing from country to city. Here the malaria mosquito occurs; in most of these regions the drainage of the land is unsatisfactory; sanitary matters are neglected. Poor people are attracted to such places because living is cheap. Under such circumstances it is not strange that malaria should be prevalent.

The construction of public works is a prolific cause of malarial and household mosquitoes in New York. At the edges of the built-up sections of the city new grades are constantly being established and streets, with their sewerage, water and gas systems are being built. The building lots adjoining the new streets are left, in many instances, at a much lower grade than the surrounding highways. In these low places, locally termed "sunken lots," water accumulates in pools, and in the pools mosquitoes multiply.

In the course of time, as the value of the land increases, the sunken lots are filled and built upon and the stagnant pools eliminated, but meanwhile they are a source of annoyance and illness.

The railways which enter New York add to the prevalence of mosquitoes of the *Anopheles* and *Culex pungens* kinds by affording breeding places on their rights of way and by interfering with the drainage of contiguous property. It is the ultimate destiny of most railroads in New York to

run in subways or open cuts with masonry walls at the sides and roofs or bridges overhead. Drainage will be provided for by deep underground conduits, and no water will stand on the right of way even in rainy weather. There are several miles of this kind of railway already built in the

Imperfect drainage due to highway construction, Concord, Staten Island.

Borough of the Bronx and an excellent section in Manhattan. The work is expensive, and the progress being made in converting old lines into this new form of construction is slow.

In the more remote suburban districts conditions are often favorable to the *Anopheles maculi-*

pennis and malaria is common. Apparently malaria mosquitoes have a preference for places which are protected from the wind, like hollows, cloves and glens, and it is among the residents of settlements in such situations that malaria is most likely to occur. The larvæ of *Anopheles* has been found in the shallow water of woodland marshes, fresh-water ponds and swamps, spring lands and sluggish brooks. In the partly built-up sections of the city the larvæ of malaria mosquitoes have frequently been met with in water in excavations, beside railroads and highways, in lakes, artificial streams, and in discarded receptacles such as butter tubs, boxes and barrels.

Beside the mosquitoes referred to, there is the third kind which causes a great deal of annoyance in some localities. This is the *Culex sollicitans*. This insect, most often called the salt water mosquito, occurs almost exclusively in those portions of New York which lie near the tide meadows. There are about 40 square miles of meadows in the city. About 150,000 acres of land are visited by the *Culex sollicitans* in great numbers. The number of people affected is considerable, for although there is an average of only 1.8 persons per acre in the regions most seriously concerned, there are numerous seaside parks and residence settlements near the edges of the salt marshes where the inhabitants and visitors are frequently annoyed by mosquitoes.

As is now well known, the salt-marsh mosquitoes breed for the most part in the stagnant pools of brackish water which lie within a few hundred feet of the uplands at the edges of the tide meadows. These pools receive rain—and occasionally some surface water, and are overflowed at unusually high tides. As a rule they have no outlets.

It is remarkable to observe to what extent

tall grass acts as a shelter for salt marsh mosquitoes, as indeed do trees, thickets, hedges and shrubbery. The lower and thicker the vegetation, the better the protection. The dense woods, thickets and shrubbery so often seen along roadsides and close to dwellings, keep enormous supplies of mosquitoes constantly at hand.

If the people of New York seriously want to get rid of their mosquitoes, there are many circumstances to favor them. Not the least of these lies in the fact that the Board of Health has taken an interest in mosquito extermination as a step toward the prevention of malaria. In the summer of 1901 resolutions were passed by the Board to the effect that all institutions and the physicians of the city be requested to furnish the Board with information in regard to patients suffering from malarial fever under their care, and that circulars on the cause and prevention of malaria be mailed to the addresses at which malarial infection had apparently been contracted. In the summer of 1902 experiments were undertaken into methods of destroying larvæ, and extensive biological and sanitary surveys were made to determine the kinds, location, extent and proper remedies for the breeding places. Some steps were taken toward applying legal remedies for unsanitary conditions which favor mosquito propagation. It was announced by the president of the Board of Health in an address delivered before the Civic Club, Feb. 7 last, that this year the work of mosquito extermination would be pushed upon the approach of warm weather.

In setting out to exterminate mosquitoes, the Board of Health has taken up a large work, for the extermination means the elimination of stagnant water, and there is hardly an acre of the 327 square miles of Greater New York which has not some standing water upon it.

Nevertheless, ample power is given to the Board to deal with this subject in a comprehensive manner, and by announcing that war is to be waged against all persons who are responsible for stagnant water, a warning has been given that this power is to be used in a vigorous manner.

Considerations of health, no less than of personal convenience, should prompt property holders and others to yield a willing compliance to the purpose of the Board. It will generally be found easier and cheaper to correct the unsanitary conditions voluntarily than to do so after being prodded into action by legal proceedings.

For those who wish to be rid of mosquitoes the first thing to be done is to see that the yards and grounds in the vicinity of their houses are put in good order. Useless receptacles which will hold water should be destroyed; tubs and barrels which have outlived their usefulness should not be cast out upon a rubbish heap, but be broken up for firewood. There should be no rubbish heap. Rain barrels and cisterns, if indispensable, should be stocked with gold fish or covered with mosquito-proof screens. Cesspools and manure pits to which mosquitoes can gain access should have enough kerosene oil thrown into them to keep their surfaces completely covered.

For the elimination of pools of limited extent which occur on private property, no remedy is so suitable as earth filling or drainage. Often a few barrowfuls of earth, taken from a nearby point, will put an end to a focus of mosquitoes for all time. Frequently the opening of an obstructed drain or brook, or the cheap construction of a proper outlet to a pool, will give vent to an accumulation of stagnant water which has been a source of annoyance for a long time. The mar-

gins of brooks and ponds should always be sharp and clean and as free as possible from weeds. Green scum and other algal growths indicate conditions which are favorable to malarial mosquitoes. In the correction of pools I do not regard the use of oil as suitable for any but pressing needs. It can afford, at best, only very temporary relief. Its best use is to stop the hatching of mosquitoes in a pool until the latter can be eliminated.

The pools and puddles formed in the course of building operations could be largely avoided if contractors would use care in avoiding the formation of unnecessary accumulations of water. Such a universal neglect of public health and convenience as is to be seen wherever building operations are in progress in New York can only be justified on the supposition that the contractors have not been aware that they were creating nuisances. Proper and simple ways to avoid forming stagnant water in excavations will readily occur to engineers and contractors when once they understand that corrective measures must be applied.

In the built-up sections of the city it would be well if the bottoms of wet excavations were made to slope to a central point or points from which such water as gathered could be drained or pumped to a place of permanent and inoffensive disposal. For pools which it may not be practicable to empty, the use of an insecticide, such as oil or crude lime, would destroy the larvæ. Kerosene, or any light oil, will answer, provided an unbroken film is kept on the surface of the puddle. If lime is used it should be applied frequently and generously and stirred well into the water after being slacked in it. One gallon of crude carbolic acid to 500 gallons of water, is an excellent insecticide.

Bodies of water, such as swamps, streams and ponds are often difficult to handle. If they are to be eliminated they should be treated according to well-considered plans made by experienced engineers in accordance with the requirements of each particular case. Work of this kind will often partake of the nature of a public improvement, and should be looked upon as a necessary step in the development of the city. Such public improvements have been extensively made in the past. A glance at some old and new maps of Manhattan will show that a vast amount of filling, grading and draining must have been done in order to eliminate the large quantity of stagnant water which originally occurred in New York.

Here is an excellent opportunity for other departments of the city to cooperate with the Board of Health in suppressing malaria and mosquitoes. Large areas of the city are now practically valueless for want of drainage that could be made useful and capable of yielding a handsome return in taxes by suitable improvements. For example, it is doubtful if another suburb so naturally attractive, yet seemingly so hopelessly neglected, as Staten Island, exists anywhere. By providing proper drainage for this island the city could convert it into a beautiful and healthful region.

A final word remains to be said about the extermination of *Culex sollicitans*. Were it practicable and feasible of application, the proper remedy for correcting the breeding places of the salt marsh mosquito would be the reclaiming of these lands in a way which would make them suitable for agriculture, building or commercial purposes. There are two ways of reclamation suited to the marshes: First, filling, by which is meant raising the level of the ground with sand and earth; and

second, dyking, by which is meant damming out the tide waters with embankments and pumping out the fresh water which collects on the inside. Both methods have been employed in or near New York, but only on a small scale; nothing large has been attempted. The economic conditions which led to the successful reclamation of 680,000 acres of English fens, of 40,000 acres of Haarlem Lake and of great tracts of sodden land in Germany, France and other parts of the world, do not seem to occur here. The experience which has been had in recovering submerged or marsh property in New York seems to indicate that only where land so reclaimed has a market value for building lots, does it pay the owners to improve it. Reclamation for the purposes of building is going on all the time; filling is the invariable process.

One practical and economical measure for reducing the number of mosquitoes *which come* from the meadows, is the destruction of the breeding places by the construction of small ditches. Suitable ditches can often be constructed for as little as 1½ cents per running foot. The ditches are designed simply to give outlet to the water which stands in the shallow pools on the meadows, and are not intended or suitable for draining the water from the saturated soil; this would be practically impossible, owing to the low level of the marshes.

One of the most beneficial steps in securing relief from marsh mosquitoes is the thinning out of foliage about houses, drives and walks. As much should be cut as considerations of sentiment and beauty will permit. If the mosquitoes are especially troublesome by day, the grass should be kept as short as possible and all foliage trimmed to a height of at least ten feet from the ground.

Before concluding, it seems desirable that a word should be said as to the extent to which mosquitoes can be exterminated. The term is not used in a literal sense. No one should think that the complete extinction of the insects is generally contemplated. It is rarely possible to destroy all the mosquitoes in a locality. This, fortunately, is not necessary with most mosquitoes, since the presence of a few is not likely to be objected to on the score of discomfort. A reduction to such a point that those which remain will not be troublesome is what is generally meant by mosquito extermination. When the mosquitoes are of the malaria-bearing type, the case is different; extermination to the utmost practicable extent should be the idea.

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